Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554 DOCKET FILE COPY ORIGINAL

In the Matter of	)	
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Allocation of Spectrum Below 5 GHz Transferred from Federal Government Use	)	ET Docket No. 94-32
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COMMENTS OF THE RADIO AMATEUR SATELLITE CORPORATION

The Radio Amateur Satellite Corporation (AMSAT) respectfully submits these comments in response to the Commission's Notice of Proposed Rule Making, ET Docket No. 94-32, released November 8, 1994.

BACKGROUND

1. AMSAT, a not-for-profit District of Columbia corporation established in 1969, is the principal membership organization of the amateur-satellite community in North America. Together with over 30 of our affiliated organizations throughout the world, we have constructed, launched and operated over two dozen satellites to date in the amateur-satellite service, of which the majority are presently in operation. These currently operational spacecraft include high-altitude, Molniya-type orbit transponder satellites capable of sustaining two-way communication over terrestrial paths well in excess of 10,000 miles (AMSAT-OSCAR 10 and AMSAT-OSCAR 13), numerous low-earth-orbit (LEO) digital store-and-forward packet radio satellites, scientific and educational payload satellites, LEO analog transponder satellites, and several spacecraft featuring combinations of these types of payloads.

2. Additional satellites for the amateur-satellite service are planned or are presently under construction by AMSAT and its affiliate organizations in Argentina, Chile, Israel, Japan, Korea, Mexico, Russia and the United Kingdom, among others. Groups in other countries such as the

Philippines and Indonesia have discussed the possibility of building amateur satellites. Many of these groups are associated with universities or have access to government or industry facilities in their countries. Indeed, owing to the worldwide and cooperative nature of amateur radio, the construction of satellites for the amateur-satellite service has emerged as a principal means of technology transfer to developing countries. One not-for-profit organization, Surrey Satellite Technologies Ltd., affiliated with the University of Surrey in the United Kingdom, has built or aided in the construction of eight such satellites, with more on the way. AMSAT itself is currently working with amateur-satellite construction groups in nearly a dozen countries to build the fourth and most advanced in a series of elliptical orbit amateur satellites called "Phase 3D". The future is certain to see a further proliferation of this highly beneficial activity, provided that enough suitable spectrum is maintained for its use.

3. Title VI of the Omnibus Budget Reconciliation Act of 1993 (the "Reconciliation Act") requires that the Secretary of Commerce shall seek to avoid "excessive disruption of existing use of Federal Government frequencies by amateur radio licensees".[1] In addition, it specifies that the Secretary shall consider, in analyzing the benefits from a particular reallocation, "the extent to which, in general, commercial users could share the frequency with amateur radio licensees."[2] In view of the integral role in this reallocation process which the Reconciliation Act assigns to the Commission (including, for example, joint spectrum planning between the Commission and NTIA[3], and sole responsibility for review and analysis of public comments in response to the NTIA's Preliminary Report,) it is clear that the intent of Congress was to protect the amateur radio community from

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[1] 47 U.S.C. ¶ 923(c) and 924(b)(2)(E).

[2] 47 U.S.C. ¶ 923(c)(3)(c).

[3] 47 U.S.C. ¶ 9221.

excessive disruption, and that the responsibility for such protection rests as much on the Commission as on the Secretary of Commerce and the President. Clearly, this is the case now that the spectrum in question has been transferred to the FCC by the Commerce Department for administration. As noted in its Preliminary Report[4], NTIA excluded 2400-2402 MHz from the proposed reallocation because of its realization that these frequencies are of vital importance to spacecraft operations in the amateur-satellite service. While AMSAT commends NTIA for this action, it falls far short of what is realistically needed in the foreseeable future. AMSAT anticipates greatly increased demand for amateur-satellite operations in this portion of the spectrum, far more than can reasonably be accommodated within a 2 MHz band. It is certainly too restricted to accommodate such wideband techniques as spread spectrum and fast-scan television, even if compression techniques are employed. AMSAT firmly expects to employ such modes on future spacecraft. The 10 MHz wide 1260-1270 MHz uplink-only amateur-satellite service allocation is available for such applications, and a similar bandwidth is needed as a downlink at 2400-2410 MHz. Obviously, such wideband techniques cannot be accommodated in lower frequency bands due to inadequate allocated bandwidth. The next highest amateur-satellite allocation (3400-3410 MHz) is available in Regions 2 and 3 only and thus is not suitable for the worldwide coverage required of amateur satellites. While plans are underway to test the suitability of amateur-satellite allocations at 5, 10 and 24 GHz, it is not clear that equipment for these bands will be readily accessible to amateurs in less developed countries, nor even less-affluent amateurs in the developed countries. Therefore, the combination of the 1260-1270 MHz band as an uplink and a 10 MHz-wide band at 2.4 GHz is necessary for the near-term future development of the amateur-satellite service. While

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[4] U.S. Dept. of Commerce National Telecommunications and Information Administration Special Publication 94-27 re Docket No. 940231-4031

it is true that the amateur-satellite service is allocated 2400-2450 MHz, the upper portion of that band is not suitable for weak-signal reception, characteristic of amateur satellites, in residential areas where most amateurs reside because of the large number of microwave ovens operating in the vicinity of 2450 MHz. These facts dictate that the amateur-satellite service requires access to 2400-2410 MHz for use as downlinks on current and future satellites, paired with the uplinks at 1260-1270 MHz.

4. Current amateur operation in the 2.4 GHz band, and all other assignments from 420 MHz to 10 GHz, are on a Secondary basis. This has worked quite well when the amateur services were sharing with Government, mostly radiolocation devices, many of which were on ships at sea or on foreign soil. However, in the cases where amateurs share with commercial users, such as in the 902-928 MHz band, a greater number of conflicts have arisen. AMSAT contends that commercial users, who may have paid large sums for access to spectrum, are most unlikely to be willing to share their expensive bounty with amateurs. From the amateur standpoint, such sharing will not be successful, especially where the amateur application involves the reception of relatively weak amateur-satellite downlink signals or very weak signals associated with long-distance terrestrial operation or earth-moon-earth communications. In addition, there are some specific proposed uses for these frequencies which, AMSAT believes, would not be compatible with sharing with amateur operation. For example, we agree with the comments of Southwestern Bell Corp. (SBC)[5] that its proposed use of this spectrum as a "local loop" would clearly not be compatible, as much of that application would be in residential areas where amateurs reside. We believe that there would be excessive disruption to the amateur services and unacceptable interference in both directions if amateurs and

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[5] Reply Comments of Southwestern Bell Corp. to FCC NOI, ET Docket No. 94-32.

such "local loop" service were forced to share spectrum. On the other hand, AMSAT believes that sharing with certain types of non-amateur users is feasible. One such example is that of spread spectrum Part 15 devices, which are presently active in the 2400-2450 MHz band with no problems that have been made known to us. This view is reflected by AT&T in its comments on the NOI[6]. Extending down to 2390 MHz the spectrum available for such devices, on a shared basis with amateur radio, would in AMSAT's opinion, provide additional capability to such devices, provide needed spectrum for amateur radio, and protect the radio astronomy work being conducted at Arecibo, Puerto Rico. Most other proposed applications of the spectrum would not provide such protection without specific restrictions, which might well prove difficult to enforce and costly to all concerned.

5. Unlike commercial satellite services for which the use of geostationary spacecraft is economically feasible and common, the high costs of launch and on-station maintenance have so far made these types of spacecraft economically prohibitive for amateur radio use. For this reason, among others, the amateur-satellite service currently utilizes satellites in low Earth orbits or highly elliptical orbits, which serve all or most of the globe with one set of uplink and downlink frequencies. Therefore, amateur-satellite frequency allocations must be coordinated internationally so that they are available for use on a worldwide basis. Any reallocation of frequencies affecting the amateur-satellite service in the 2400-2450 MHz band, including the introduction of additional or substituted sharing partners in the United States, can only have adverse effects on the entire service worldwide, and thus must be coordinated with all other national administrations through the ITU process.

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[6] Reply comments of AT&T to FCC NOI in ET Docket No. 94-32.

6. Although current amateur and amateur-satellite use of the 2.4 GHz band may be considered light by standards used to judge other parts of the spectrum, the use of this band is expected to increase greatly in the next few years, particularly with the launch of the Phase 3D amateur satellite in April 1996. Like other users of the radio spectrum, amateurs tend to migrate from lower frequencies to higher frequencies as time passes, suitable equipment becomes available, and the state of the art advances. Amateur radio is also unlike many commercial users of the spectrum in that amateurs are a diverse group, both geographically and in terms of economic status. A large commercial organization can be given access to spectrum and then can produce, or have produced in a relatively short time, the necessary earth station equipment to use that spectrum. Amateurs, on the other hand, must wait for a few very intelligent and technically sophisticated individuals, or a handful of manufacturers, to see the need and come up with suitable equipment. Then, most individual amateurs must either construct the equipment from magazine articles or purchase the newly created commercial equipment. Currently, there is very little commercial equipment available for the 2.4 GHz band. However, with the launch of Phase 3D, equipment availability and occupancy on this band is certain to increase markedly. Another factor is that commercial equipment for the amateur market generally becomes available for higher frequencies as time passes. For example, a few years ago, very little equipment was available for the 1240-1300 MHz band. Now, several quite serviceable units for that band are on the market. So, AMSAT contends that it is not appropriate to judge whether or not certain frequencies in the microwave bands should be retained for amateur use, based strictly on current occupancy. Equipment availability, and indeed the level of interest on the part of amateurs, is also greatly influenced by the future prospects of a band. In the case of the 13 cm band (2300-2310 and 2390-2450 MHz), amateurs originally had access to the entire 2300-2450 MHz band. The 2310-2390 MHz portion was withdrawn several years ago, ostensibly

to provide for flight test telemetry. That use was never made of this 80 MHz of spectrum and more recently, part of that range was made available for Digital Broadcasting (sound). This was after the airborne telemetry interests adamantly stated that it would be too costly for them to move from 1.5 to 2.3 GHz. Thus, the U.S. became one of the few countries assigning 2.3 GHz to Digital Broadcast (sound), instead of 1.5 GHz as most of the rest of the world does. So amateurs lost a large chunk of spectrum in the name of national security, to an application which the supposed users did not want to put there. This, in conjunction with the new threat posed by the present proceeding, has certainly diminished the interest of commercial companies in producing 2.4 GHz equipment and represented a deterrent to amateurs to making investments in equipment for the band. Thus, looking at current amateur activity in the 2300-2310, 2390-2450 MHz band, in the midst of past reallocation actions and a proposal to withdraw more of the band, becomes somewhat of a self-fulfilling prophecy. If amateurs lose 25 MHz more at this time with no assurance that 2300-2310 MHz will not also be lost in a few years, how much commercial equipment can be expected to be offered for this part of the spectrum, and what level of commitment can amateurs be expected to devote to it? It should be unnecessary to remind the Commission that amateurs in recent years have also lost 220-222 MHz and, in some parts of the country, 420-430 MHz.

7. It might not be apparent why AMSAT is concerned with segments of the amateur bands which are not authorized for the amateur-satellite service. However, any spectrum lost by amateur radio puts additional pressure on the amateur-satellite segments as other amateurs crowd into them. A prime example is in the 435-438 MHz amateur-satellite service band. With the loss of 420-430 MHz in parts of the country and threats to it in the rest, more and more amateur television operators are using the 435-438 MHz amateur-satellite service segment, resulting in interference to amateur-satellite communications. Thus, it is quite logical to conclude that loss of 2390-2400 and 2402-2417

MHz, and the threat to 2300-2310 MHz, would have a similar impact on the remaining segments, 2400-2402 and 2417-2450 MHz. As already stated, use of that latter segment by amateurs is already jeopardized by the presence of ISM devices, especially microwave ovens.

8. A discussion of current and past amateur-satellite usage of the 2.4 GHz portion of the spectrum was presented in AMSAT's comments on the FCC's Notice of Inquiry[7]. For reference, this material is updated here as *Appendix* A.

9. The intense crowding taking place on the lower VHF and UHF amateur bands necessitates the use of the higher-frequency bands by amateur satellites. Particularly bad is the situation in the 144-146 MHz band, where the amateur and amateur-satellite services are co-primary. This is the only portion of the VHF spectrum presently allocated to the amateur-satellite service on a Primary basis by the ITU. Because of intense usage by other amateur applications, the only part of this band regularly used by the amateur-satellite service is 145.8-146.0 MHz. Co-channel and adjacent-channel interference, a direct result of the intense crowding, is increasingly making the band difficult to use for satellites, especially for the relatively weak-signal satellite downlinks. In addition to legitimate amateur use of the band, the ready availability of inexpensive equipment intended for the amateur market has resulted in extensive use of this band by non-amateurs for personal and commercial communications in many countries, especially in Central America, Asia and the Pacific Rim, despite ITU regulations to the contrary. First-hand observations by radio amateur astronauts flying in the Space Shuttle and cosmonauts aboard the Russian space station MIR have confirmed that this is a significant and growing problem for amateur space communications. The narrow band available to satellites and these various kinds of interference

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[7] Comments of the Radio Amateur Satellite Corp. (AMSAT) to FCC NOI on ET Docket 94-32.

make migration to higher frequencies all the more urgent.

10. A similar situation is developing in the 435-438 MHz band allocated on a Secondary basis by the ITU to the amateur-satellite service. In many parts of the world, use of this band for satellite uplinks is rendered virtually impossible at times by the presence of high-powered radar stations such as PAVE PAWS. This has proven especially true with respect to digital applications, such as packet radio and earth-to-space command links.

11. A critical problem facing amateur radio is the availability of sufficient spectrum in view of the proliferation of modes of operation, many inherently wideband in nature, and the increasing number of amateur radio operators since institution of the code-free license. Figures indicate that the number of licensed amateur stations in the U.S. is growing at the rate of approximately 7.5 percent per year, with most of that growth attributed to the no-code Technician License. Both of these situations will require greater use of the microwave bands for amateur satellites in coming years, especially the 2.4 GHz band paired with the 1260-1270 MHz uplink-only band. A mode of operation, growing in popularity is fast-scan amateur television. Several manufacturers currently offer low-cost amateur television transmitters for the 420-450 MHz band. As no such amateur television equipment is manufactured for any of the amateur bands above 450 MHz, this band is receiving the brunt of amateur television operation. Since amateur FM repeaters occupy almost all of the 440 to 450 MHz range, and 420 to 430 MHz is not available everywhere in the U.S., most amateur television operation takes place between 430 and 440 MHz. Many of these commercial amateur TV transmitters, and most home constructed units, transmit signals 8 MHz in width (both sidebands), often causing interference to reception of amateur satellites in the 435 to 438 MHz amateur-satellite service band as well as to weak-signal experiments taking place near 432 MHz.

This problem is greatly exacerbated in the many other countries of the world where only 430-440 MHz, or parts thereof, is available for amateur operation.

12. Amateur satellites are completely different from satellites built for other applications. In the case of commercial or government satellites, while the spacecraft is being constructed and prepared for launch, suitable ground station equipment is being developed and deployed. Usually, both of these are funded and directed by the same company or government agency. This assures that the ground equipment will be in place when the space segment comes on line and that the two will be compatible with one another. This is not true with amateur satellites. In this case, the space segment is constructed by a specific amateur group such as AMSAT, or a collection of such groups. In planning the satellite, the constructors attempt to understand the current and future capabilities and needs of individual amateurs throughout the world. This often means that they must compromise in the design of the satellite, frequently choosing lower-frequency bands and lower-speed data rates than would be optimal otherwise. This puts the amateur-satellite builders in a serious bind. If the lower bands are too narrow and crowded, and the higher ones offer a greater challenge than can be placed on people in poorer countries, then the low microwaves (1.2 and 2.4 GHz) become the only acceptable choice. The next highest amateur-satellite band, 3400-3410 MHz, is not available worldwide, and therefore is most unlikely to be used for amateur satellites unless a worldwide allocation can be obtained. Thus, it is the 2400 MHz band which will bear the greatest burden of supporting the growth of the amateur- satellite service in the future, especially since the use of 1.2 GHz for amateur satellites is restricted to uplinks only under ITU regulations. But it is difficult to see how the 2.4 GHz band can accommodate this demand if only 2 MHz of spectrum is available.

13. Currently, the amateur-satellite service allocation in the 2.4 GHz region is 2400-2450 MHz, both in the U.S. and international tables. It would appear that to efficiently use the 10 MHz-wide uplink assignment at 1.2 GHz, a like assignment at 2.4 GHz would be reasonable and necessary.

14. While there is some commonality of technical interest between amateur operators who use narrowband weak-signal modes, such as earth-moon-earth or long-haul terrestrial means of propagation, and those amateurs participating in satellite operation, use of common or nearby frequencies by these two groups often leads, in practice, to mutually destructive interference. Furthermore, in view of the weak signals involved, relatively narrow allocations, available on a Primary basis, form the best approach of accommodating and encouraging earth-moon-earth and long-haul terrestrial operation, both of which have yielded significant technical advances in the past and are likely to do so in the future. Currently, most amateur weak-signal experimentation in the 2.4 GHz band is conducted in the vicinity of 2304 MHz, although in some countries other frequencies are employed due to non-availability of the 2300-2310 MHz segment to amateurs. Like satellite operation, although to a lesser extent, weak-signal operation is best accomplished on common worldwide allocations. This is especially true of earth-moon-earth operation. Needless to say, successful earth-moon-earth operation requires the utmost in performance of all elements of the system from high-power amplifiers, receiving pre-amplifiers and antennas. Unfortunately, wide frequency separation between transmit and receive frequencies, necessitated by differing allocations, often leads to less-than-optimal equipment performance, especially in the case of antennas.

ADVANCED TECHNOLOGY PLANNING AND EXPERIMENTATION

15. An important purpose of the Reconciliation Act is facilitating the development of "new and innovative technologies" for the benefit of the public.[8] The amateur-satellite service is in the

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[8] P.L. 103-66, Sec. 6002 et seq.

forefront of just such technologies. New satellite and ground-based telecommunications systems being authorized by the FCC have benefited from the advances made in experiments developed for use in the amateur-satellite service. To cite one significant example, the LEO satellite systems now being authorized by the FCC use packet radio hardware and software technologies originally developed by the amateur radio community for use in the amateur-satellite service, particularly for the AMSAT MICROSATs and the University of Surrey's UOSATs. In fact, one of the applications recently received by the Commission in the so-called "Little LEO" proceeding propose a satellite based on the MICROSAT design developed by AMSAT volunteers and used in the construction of four satellites launched in January 1990. Later, this same design was embodied in a spacecraft, known as EYE-SAT, built by Interferometrics, Inc. of McLean, Virginia.

16. As an extension of this spinoff concept, the amateur-satellite community is evolving standards for high-speed digital data and digital video transmission using compression technologies that are ideally suited for small-satellite applications. In order to test and implement this type of technology, frequency allocations with adequate bandwidth are essential. As previously stated, the 2.4 GHz frequency band is the best suited frequency band for the downlink for this type of experimental digital communications. The communications transponders used would pair uplinks at 1260-1270 MHz with downlinks in the 2400-2410 MHz frequency band.

17. Amateur-satellite groups are also doing pioneering work in the development of high-efficiency, high-power amplifiers for this portion of the radio spectrum. Linear 2.4 GHz amplifiers with efficiencies as high as 40 percent have already been developed by the amateur community. AMSAT's Phase 3D spacecraft will carry solid-state amplifiers for the 2.4 GHz amateur-satellite band capable of in excess of 100 watts of RF power output and over 10 kilowatts of effective radiated power.

18. These technologies under development by amateur groups, when taken together and with an adequately wide 2.4 GHz amateur-satellite allocation, will provide powerful demonstrations of low-cost digital video and data transmission techniques. These technical approaches differ from direct broadcast technologies because they are bi-directional and will involve multiple-access, widely-scattered amateur stations. Both time-division and code-division multiple-access techniques are under consideration.

19. In addition to experimentation with digital video and high-speed packet data links, several amateur radio groups have expressed an interest in investigating low-cost spread spectrum techniques. Spread spectrum communications experiments are important because they may lead to feasible methods of spectrum sharing by various commercial satellite and terrestrial services, applications currently under consideration by the FCC. In fact, hardware is presently being constructed for tests leading to employment of just such a spread spectrum technique in a future amateur satellite.

FREQUENCY-SHARING AND INTERFERENCE CONSIDERATIONS

20. We have already mentioned interference experienced in the amateur-satellite service as a result of high-powered devices such as radars, and interference arising from amateur and non-amateur use of the 144-146 and 435-438 MHz bands. Some interference from radars is also present in the 1260-1270 MHz uplink band. The 2.4 GHz band presents a unique challenge in that ISM devices, principally microwave ovens, are present. Microwave ovens are particularly detrimental to amateurs because they are found in most homes, and most amateurs operate in residential areas. For this reason, amateur and amateur-satellite operation should be afforded a part of the band as far away from that occupied by ISM devices as possible. The Commission is reminded that, following a study done for the Voice of America, the U.S. sought an allocation at WARC-92 for

broadcast-satellite service (sound) from 2310-2360 MHz - as far away, in that band, from the 2450 MHz ISM center frequency as possible. Data provided by NTIA in its Preliminary Report show in some instances a relatively wide frequency dispersion of ISM interference around the 2450 MHz center frequency. This supports the conclusion that applications involving reception of weak signals in residential areas is jeopardized by use of frequencies in close proximity to microwave ovens. It has been shown that experimental weak-signal amateur operation, such as earth-moon-earth and long-haul tropospheric communications, must have as clear a frequency as possible. This potentially valuable type of work is currently concentrated at 2300-2310 MHz, specifically near 2304 MHz. AMSAT supports a continued suitable allocation for this activity.

21. As discussed above in more detail, the amateur-satellite service presently utilizes and expects to significantly expand its use of the 2.4 GHz band. For various reasons, this band is a prime area of the spectrum for amateur communication experiments and applications. Due primarily to the extremely high cost of geostationary satellites, no amateur spacecraft of that type has yet been launched and none is in serious development at the present time. Therefore, satellites in the amateur-satellite service are in lower or elliptical orbits that cover virtually the entire earth, albeit not all regions simultaneously. Consequently, the frequencies used by amateur satellites must be available worldwide. Thus, unlike terrestrial applications or those involving geostationary satellites, allocations of spectrum to the amateur-satellite service must be made consistently throughout the world, rather than on a national or regional basis. Therefore, any decisions with regard to allocations for the amateur-satellite service made in the United States must be coordinated with other governments. Otherwise, the results are likely to prove useless for the purposes for which they are intended. A case in point is the 3400-3410 MHz amateur-satellite service allocation currently provided for in the ITU Table of Allocations. This segment is stated as being available, but in

Regions 2 and 3 only. Since it is not available in Region 1, it has not yet been employed for amateur-satellite use, and is the only band between 21 MHz and 24 GHz that has not been considered for inclusion in the Phase 3D spacecraft now under construction.

22. In addition to satellite and weak-signal communications, many amateur experimenters are interested in relatively short-range activities, such as amateur television and high-speed data transmission. Some of that type of work is already being accomplished in the 2.4 GHz band. These kinds of activities generally require relatively large bandwidths and higher received signal levels than do satellite, long-haul tropospheric or earth-moon-earth communications and, therefore are somewhat more tolerant of having to share spectrum with other users. The general use of relatively narrow-beam, directive antennas, characteristic of this kind of amateur activity, also aids in such sharing. These wider-band, shorter-range activities are certain to increase in number in the future, and will need to be accommodated.

RECOMMENDATIONS

23. In view of these considerations and the anticipated near-term future needs of the amateur and amateur-satellite services, AMSAT urges the Commission to take the following actions:

a. Establish an amateur and amateur-satellite allocation from 2400-2410 MHz on a Primary basis, with no additional sharing partners other than the existing ISM assignment and spread spectrum Part 15 devices.

b. Retain access, for the amateur service, to 2390-2400 MHz and, for the amateur and amateur-satellite services, to 2410-2450 MHz, both on a Secondary basis shared with what are, according to the Commission's determination and the considerations outlined in Paragraphs 4 and 20-22 above, the most compatible sharing partner(s). As discussed in Paragraph 4, AMSAT suggests that the best sharing for amateurs of the 2390-2400 MHz segment would be to expand the allocation available to Part 15 spread spectrum devices.

c. Provide at least 1 to 2 MHz of spectrum below 2400 MHz, on a Primary basis, for the amateur service in order to accommodate weak-signal terrestrial and earth-moon-earth experimentation. This small window should be as far from the 2450 MHz center frequency as possible, preferably near the presently used 2304 MHz frequency.

CONCLUSION

24. AMSAT believes that by implementing the foregoing recommendations, the Commission will be using these frequencies in the most optimum manner, as well as complying with the intent of the Reconciliation Act. At the same time, it will insure the continued health of the amateur-satellite service and provide it, and the amateur service, with the renewed confidence, including assurance to prospective manufacturers of equipment and components which amateurs need, to go forward with new innovative techniques in this portion of the spectrum.

RESPECTFULLY SUBMITTED,

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By William A. Tynan
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December 16, 1994

Appendix A

Past, Current and Future Use of 2.4 GHz Band by The Amateur-Satellite Service

The amateur-satellite community has pioneered the use of the 2300-2450 MHz band for amateur satellites since the early 1970s:

AMSAT-OSCAR 7, launched in 1974, carried a beacon on 2304.1 MHz.

UOSAT-OSCAR 9, built at the University of Surrey in the U.K. and launched in 1981, contained beacons on 2401 and 10,470 MHz.

The French-built Arsene amateur satellite, launched in 1993, included a 16 kHz-wide downlink at 2446.500 MHz. Unfortunately, that transmitter failed several months after launch.

CURRENT USAGE

Several amateur satellites currently utilize the 2.4 GHz band:

AMSAT-OSCAR 13, launched in 1988, has a transponder downlink on 2400.711-2400.747 MHz, with a beacon at 2400.650 MHz. This downlink has seen increasing use, especially over the past year.

UOSAT-OSCAR 11, built at the University of Surrey in the U.K. and launched in 1984, carries a beacon on 2401.5 MHz, which continues to function.

PACSAT-OSCAR 16 (AO-16), one of the four MICROSATs built in the U.S. in the late 1980's and launched in January 1990, contains a beacon on 2401.1 MHz, which is presently functional.

DOVE-OSCAR 17 (DO-17), another of the MICROSATs, has a beacon on 2401.220 MHz. This has proved invaluable in attempts to rescue this satellite from mission-threatening situations involving interference to the 144 MHz command receiver from the satellite's 145.825 MHz downlink transmitter. Often, the 2.4 GHz downlink has been the only means to confirm the satellite's acceptance of commands.

NEAR-TERM PLANS

The most immediate planned amateur satellite use of the 2.4 GHz band is for Phase 3D. This large amateur satellite is scheduled for launch in April 1996 on the Ariane 5 launch vehicle, currently under development by the European Space Agency. Phase 3D will include a number of uplinks and downlinks in amateur-satellite service bands from 21 MHz to 24 GHz. At 2.4 GHz, both uplinks and downlinks are planned utilizing the following specific frequencies:

Downlink	2400.500 - 2400.900 MHz
Uplinks	2400.100 - 2400.500 MHz & 2446.000 -2446.400

The 2446 MHz uplink is especially aimed at evaluating the potential interference, in orbit, of various ISM devices, including microwave ovens.

LONGER-TERM PLANS

The amateur-satellite service can be expected to make significant use of the 2.4 GHz band, especially for downlinks, in the future. For example, AMSAT has begun a planning process to define what types of satellites will be built following the launch of Phase 3D. Certainly the 2.4 GHz band will play heavily in any such new amateur satellites. With Phase 3D expected to last up to 15 years, and using 2400-2401 MHz, any such new satellites would look to nearby frequencies above 2401 MHz. With wideband techniques being considered more and more, it is obvious that 2400-2402 MHz, as withheld from transfer from Government to the private sector by NTIA, will be inadequate to support the kinds of new amateur satellites being envisioned.